ASSESSING GEOLOGICAL CONDITIONS AT THE OCEAN FLOORS OF THE TRAPPIST-1 ROCKY PLANETS. Melia Kendall[1] and Paul K. Byrne[1], [1]Planetary Research Group, Department of Marine, Earth, and Atmospheric Sciences, North Carolina State University, Raleigh, NC 27695, USA (mkendal@ncsu.edu).

Introduction: The TRAPPIST-1 planetary system was reported in 2016 [1], and consists of seven confirmed rocky planets that orbit that red dwarf star; three of those planets are situated in the star's habitable zone. The discovery of these planets was, and continues to be, of substantial scientific and public interest, with numerous studies working to characterize surface conditions and the prospect for habitable conditions.

Similar to the icy satellites of the outer Solar System [2–4], the TRAPPIST-1 planets may have an interior structure that includes a rocky core below a deep liquid water ocean, with an icy shell and/or thick volatile atmosphere atop [e.g., 5]. Although, as for the icy satellites, much work focuses on conditions at the planetary surface, it is possible to place first-order estimates on the geological conditions at the ocean floors of these bodies, too. Chemical reactions at the rock–water interface might support chemoautotrophic habitats there [6], and by analogy with Earth, hydrothermal systems and even seafloor volcanism could be present there.

Building on work to characterize rock-mechanical conditions at the seafloors of icy satellites including Europa, Titan, Ganymede, and Enceladus [7], here we consider how gravity and overburden pressure, and ultimately rock strength, vary with depth inside each of the seven TRAPPIST-1 rocky planets.

Approach: To estimate the mechanical strength of the ocean floors of these worlds, we used published interior structure models for all seven planets [5]. These workers assumed uniform density of rock, iron, and H_2O in developing these models, and we follow that same approach (and density values) here. Following an earlier approach [7], we first calculate how gravitational acceleration, g, varies with depth (in terms of body radius, r), with

$$\delta g/\delta r = 4\pi G\rho_r - 2(g/r), \quad (1)$$

where ρ_r is the local material density and G is the gravitational constant. The change in overburden pressure, P, is then given by

$$\delta P/\delta r = -\rho_r g r. \quad (2)$$

Fault strength can then be characterized, under the assumption that P corresponds to one of the principal stress components (i.e., σ_1 or σ_3) by the equations

$$\sigma_1/\sigma_3 = (S_v)/(S_h) = (\{\mu^2+1\}^{0.5}+\mu)^2 \quad (3)$$

and

$$\sigma_1/\sigma_3 = (S_H)/(S_v) = (\{\mu^2+1\}^{0.5}+\mu)^2 \quad (4)$$

for normal and thrust faults, respectively [8]. Here, σ_1 and σ_3 are the maximum and minimum principal stresses, respectively, S_v is the vertical stress, S_h and S_H are the minimum and maximum horizontal stresses, respectively, and μ is the coefficient of friction. We consider a value of μ of 0.3 to represent hydrously altered rock (e.g., serpentinite), to account for the prospect that rocks at these seafloors have been mineralogically hydrated by interaction with the overlying ocean.

Results: We report values for g and P at the ocean floors of these worlds (per the interior published models of Barr et al. [5]) in **Table 1**. We find that pressures at the bases of these water/water-ice columns range from ~10 MPa, comparable to ~1 km water depth on Earth, to 2.8 GPa, approximately twice that of the water pressure at the ocean floor of Ganymede [7].

Table 1. *Preliminary gravitational acceleration and overburden pressure values for the ocean floors of the seven TRAPPIST-1 planets (from published interior structure data [5]).*

Planet	R_{rock} (km)	g (m.s^{-2})	P (MPa)
b	4,839	9.37	1,520
c	6,728	14.37	10.4
d	4,410	14.79	708
e	2,841	9.53	1,650
f	3,299	11.07	2,170
g	4,463	14.97	2,780
h	1,031	3.46	535

Outlook: With these data, it is possible to calculate the strength of both normal and thrust faults, and then consider further geophysical properties such as the depth to the brittle–ductile transition within these rocky interiors [cf. 7]. From there, an assessment of likely tectonic vigor, as well as the prospect for plate mobility and cycling, is possible.

References: [1] Gillon M. et al. (2017) *Nature*, *542*, 456–460. [2] Pappalardo R. T. et al. (1999) *JGR*, *104*, 24,105–24,055. [3] Iess L. et al. (2012) *Science*, *337*, 457–459. [4] Thomas P. C. et al. (2016) *Icarus*, *264*, 37–47. [5] Barr A. C. et al. (2018) *Astron. Astrophys.*, *613*, A37. [6] Glein C. R. et al. (2015) *Geochim. Cosmochim. Acta*, *162*, 202–219. [7] Klimczak C. et al. (2019) *Lunar Planet. Sci. Conf.*, *50*, abstract 2912. [8] Zoback M. D. (2007) *Reservoir Geomechanics*, Cambridge Univ. Press, pp. 461.